stock solution (1M Zn^{++} in 5.5N NaOH) by combining 8.139 g of ZnO (m.w 81.39 g/mol) with 30 gm of NaOH pellets (m.w. 40 g/mol) and making up to 100 ml with D.I water under constant stirring. The resulting solution is a 1M Zn^{++}+ 5.5N NaOH. Step 2: dilution of (1M Zn/5.5N NaOH) to a 4N NaOH solution by taking 100 ml of (1M Zn^{++} in 5.5N NaOH) stock solution and making it up to 137.5 ml with D.I. water—the resulting solution is 0.73M Zn^{++} in 4N NaOH. (Note that the reported solubility limit of Zn^{++} in 4N NaOH is 0.37M.) Note that electrolytes with NaOH concentrations in the range of 2-4N are found to provide satisfactory zincate ion concentration in combination with tolerable ferrous ion concentration and tolerable corrosive solution properties, whereas NaOH concentrations above 4N result in rapidly reduced ferrous ion concentrations along with an electrolyte which is more corrosive.

[0088] Experiments confirm that 0.73M Zn^{++} in 4N NaOH and 0.4M Zn^{++} in 2.2N NaOH are stable for at least four weeks.

[0089] Although the present invention has been particularly described with reference to certain embodiments thereof, it should be readily apparent to those of ordinary skill in the art that changes and modifications in the form and details may be made without departing from the spirit and scope of the invention.

What is claimed is:

1. A flow battery comprising:

at least one cell comprising a low resistance positive electrode in a positive half cell and a low resistance negative electrode in a negative half cell; and

a pump for circulating electrolyte through a flow channel of said negative half cell, wherein said pump and said channel are configured to provide a high rate of mixing of said electrolyte in a deposition region proximate a deposition surface;

wherein said electrolyte has a metal ion concentration greater than the equilibrium saturation concentration of the metal ion in said electrolyte.

2. The flow battery of claim **1**, wherein the resistance across a cell results in less than 200 mV loss at an operating current density of 100 mA/cm^2.

3. The flow battery of claim **1**, wherein a mass transfer coefficient of said electrolyte in said deposition region is sufficient to maintain an electrolyte concentration of metal ions proximate said deposition surface for a substantially uniform deposition of metal on said deposition surface.

4. The flow battery of claim **3**, wherein said mass transfer coefficient is greater than approximately 2×10^{-4} m/s.

5. The flow battery of claim **1**, wherein said electrolyte has sufficiently high metal ion concentration for deposition rates on said deposition surface that sustain said uniform high current density during a charging cycle.

6. The flow battery of claim **1**, wherein said electrolyte has a zinc solubility of greater than 0.37M in 4N NaOH.

7. The flow battery of claim **1**, wherein said electrolyte has a zinc solubility of greater than 0.7M in 4N NaOH.

8. The flow battery of claim **1**, wherein the flow of said electrolyte through said flow channel is turbulent.

9. The flow battery of claim **1**, wherein a Reynolds Number of said flow channel is greater than approximately 1300.

10. The flow battery of claim **1**, wherein a Sherwood Number of said flow channel is greater than approximately 21.

11. The flow battery of claim **1**, wherein said uniform high current density is greater than 100 mA/cm^2.

12. The flow battery of claim **1**, further comprising at least one mixing element in said flow channel.

13. The flow battery of claim **12**, wherein said mixing element induces turbulence in said flow channel.

14. The flow battery of claim **12**, wherein said mixing element is chosen from the group consisting of wires, arrays of cones, arrays of pyramids, foam, mesh, and tubes.

15. The flow battery of claim **1**, further comprising a flow calming structure positioned in said electrolyte circuit after said flow channel of said negative half cell.

16. The flow battery of claim **1**, wherein said flow battery is a ZnFe flow battery.

17. A method of charging a flow battery comprising, circulating electrolyte through a flow channel of a negative half cell in said flow battery, wherein said flow channel is configured to provide a high rate of mixing of said electrolyte in a metal deposition region proximate a deposition surface of said negative half cell.

18. The method of claim **17**, wherein said circulating includes pumping said electrolyte through a fluid circuit, said fluid circuit including said flow channel.

19. The method of claim **17**, wherein said electrolyte has a metal ion concentration greater than the equilibrium saturation concentration of said metal ion in said electrolyte.

20. The method of claim **17**, further comprising providing a uniform high current density across a low resistance positive electrode and a low resistance negative electrode of said flow battery, said high current density passing through said metal deposition region proximate said deposition surface of said negative half cell.

21. The method of claim **17**, wherein a mass transfer coefficient of said electrolyte proximate said deposition surface has a value in the approximate range of 5.3×10^{-4} m/s to 12.4×10^{-3} m/s.

22. A ZnFe flow battery comprising:

at least one cell comprising a low resistance positive electrode in a positive half cell and a low resistance negative electrode in a negative half cell;

a pump for circulating electrolyte through a flow channel of said negative half cell, wherein said pump and said channel are configured to provide a high rate of mixing of said electrolyte in a deposition region proximate a deposition surface;

wherein said electrolyte has a zinc metal ion concentration greater than the equilibrium saturation concentration of said zinc metal ion in said electrolyte, and wherein a mass transfer coefficient of said electrolyte in said deposition region is sufficient to maintain an electrolyte concentration of zinc metal ions proximate said deposition surface for a substantially uniform deposition of zinc metal on said deposition surface at a uniform high current density.

23. The flow battery of claim **22**, wherein said uniform high current density is greater than 70 mA/cm^2.

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